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TECHNOLOGY UTILIZATION - THE SPINOFF FROM AEROSPACE TECHNOLOGY TO THE CIVILIAN SECTOR

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ABSTRACT

Government-sponsored technology not specifically aimed at the civilian sector or "aerospace" technology in the large sense has been of enormous benefit to the civilian sector. It has produced current tangible results in satellite applications, has fostered a number of major innovations, and generated a host of smaller innovations. It is generating technology whose benefits will not be recognized for years, it is providing a part of the inspiration that keeps this country an innovating society. It, like other investments in new technology, is the best investment this country can make.

The topic of this talk is Technology Utilization, the Spinoff of Aerospace Technology to the Civilian Sector. We at NASA feel strongly that the technology generated in the aerospace program is of great significance to the nation. This talk is a personal attempt to articulate this feeling. I wish to talk about technology utilization in the largest sense. To do this I will use the following ground rules.

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1. I am going to talk primarily about the benefits already derived from aerospace technology to make my case. A prognostication of valuable future contributions is of doubtful value because everyone's crystal ball is pretty cloudy.

2. I am going to talk about any Government-sponsored technology which is not aimed at the civilian sector. That is, I am not going to restrict myself to NASA technology or even all aerospace technology, but will cite examples and benefits from any Government-sponsored work not originally directed toward the civilian sector. I will use the term "aerospace" technology for this larger technology source for convenience and will omit the quotes on aerospace hereafter.

3. I am going to talk about any area where the contribution of aerospace technology is large even though there may also be a substantial contribution from work directed toward the civilian sector. That is, in some of the examples I cite, the contributions of both aerospace and civilian technology are large, with both contributions essential to the results.

4. I am not going to speak of the spinoff from peaceful, "NASA-type", aerospace technology to defense. A strong defense is not normally thought of as belonging to the civilian sector but even a casual glance at world history will show that it is one of the most important items in the entire sector. History is full of examples of societies with inadequate defense who lost most or all of the goodies in the civilian sector, not to

mention losing their freedom and often their lives. This reminder of the importance of defense to the civilian sector is important for perspective. I will not discuss it further but concentrate on the non-defense benefits of spinoff.

5. I will cite benefits from many different periods of time. That is, I will not restrict my discussion to the nine years since NASA was formed. The fruits of technology are not always immediate. It often takes a considerable period of time before the value of certain work becomes apparent. A few examples: (due to Lesher and Howick and to Naugle) an English patent for a "machine for transcribing and printing letters" was issued to Latham Scoles in 1714. It was 150 years later that Remington bought the patent rights and started to produce the first commercial typewriter. DDT was synthesized in 1874, but its value as an insecticide was not recognized until 1939. Or an older example, Apollonius of Perga discovered conic sections in the third century B.C. It was the 17th century before they were applied to problems of engineering. Very pertinent to the topic of this conference is electricity. Modern studies of electricity started around 1600 when Dr. William Gilbert, the physician of Queen Elizabeth, studied static electricity and made observations of things which could be electrified. Among others amber rubbed by cat's fur would produce an attraction. So Gilbert named the attraction "vis electrica" after the Greek word for amber. One hundred-thirty years later, the Englishman,

Gray, showed that electricity could be conducted along metallic surfaces. Shortly thereafter, in 1733, a Frenchman, DuFay, discovered that there were two kinds of electricity and that unlike kinds attract and that like kinds repel. The inverse square law of attraction was discovered by a French military engineer, Coulomb, in the late 1780's. Volta made the first battery in 1800. Oersted showed that an electric current generated a magnetic field in 1821. Michael Faraday, whom we honor today, made his most famous discovery in 1831. Yet it was the late 1800's before any appreciable "spinoff to the civilian sector" really came about, over 250 years after Gilbert, one hundred after Coulomb, and about fifty years after Faraday.

6. I will discuss the spinoff from aerospace technology in the following categories:

A. Direct

1. Satellite Applications
2. Individually Large Benefits
3. Substantial Benefits by Accretion of Many Small Advances

B. Indirect (By-products)

1. Unpredictable
2. Inspirational

First let us discuss those benefits to the civilian sector which come from direct satellite application. These are familiar and obvious civilian applications of aerospace technology. You are all familiar with the weather and communication satellite programs, so I will speak of them only briefly. Weather satellites provide global weather coverage and enable us to make better weather predictions immediately. In addition to immediate improvement in local weather forecasting, global weather coverage permits us to hope that theories of long range weather forecasting can be improved. The National Academy of Sciences in a 1965 report estimated that if accurate weather forecasting could be extended to two weeks in the future the potential saving from such forecasting could reach $2.5 billion annually for the United States alone. Communication satellites are in commercial operation. The Communication Satellite Corporation which owns the transoceanic communication satellites and is part owner of the U.S. ground receivers has a market value about $600,000,000 at current (August 1967) market prices. Several organizations are now contending for the right to build and operate domestic communication satellites.

Less known because of military security are satellite navigation systems which permit ships and aircraft to readily determine their position. It has recently been announced that this capability will now be made available to the civilian sector. A new idea which you may not have heard about is the Earth Resources Satellite. It has been found that the observations of a variety of sensors can give a great deal of information about earth resources.

For example, infrared photography can show the onset of disease in forests due to the fact that diseased trees exhibit a change in temperature. Infrared can also be used to locate fresh water which is escaping along coast lines permitting steps to be taken to conserve this water. It has been estimated that this lost water represents about 1/6 of our supply of fresh water. This is not trivial financially when you consider that the value of the water used for agricultural purposes in the western states has been estimated at $1.5 billion per year. The Gulf Stream can be mapped from satellites because it is about 10 degrees warmer than surrounding waters. Fishing experts say that they would know consistently where to find several species of fish if they could follow accurately the daily movements of the Gulf Stream. Ordinary color photography has shown considerable detail on the distribution of currents and sediments in the shrimp beds of the Gulf of Mexico. Satellite sensors can be of value in geological surveys helping to locate mineral deposits. Radar can penetrate vegetation and reveal topographic details such as the difference between fine grained structure like sand or clay and coarser grained structures. The mineralogical and chemical composition of rock surface can be determined from reflectivity in the 8-13 micron wavelength band. Ordinary color photography from space has revealed geological structures and rock units in remote areas that had not been mapped before. Even in a major mining district geological structures have been found not indicated in the most up-to-date geological map of that area.

Satellites might provide early warning of forest fires, can map navigation routes in shoal waters, can detect underground geothermal power sources, can help in forecasting ice breakup in the Great Lakes in the spring, can locate and monitor the movement of broad scale pollution in lakes and estuaries, and have even provided information helping diamond miners in the Namib Desert of Southwest Africa locate promising areas for exploration.

It might be argued that all these observations could be made from aircraft and indeed some are. However, the economics of large scale continuing measurement demands the use of satellites. The Department of Interior has estimated that an Earth Resources Satellite can obtain in 17 days data which would take aircraft 20 years to assemble.

Plans are being made to design and test an Earth Resources Satellite which can make all these observations concurrently. In spite of my initial warnings about prognostication, it is probably safe to predict that this will be another extremely valuable application of satellites to the civilian sector.

I would like to talk now about the second area of direct contributions to the civilian sector of aerospace technology, areas where a large, evident contribution has been made by Government-sponsored technology. The first and most obvious is of course commercial aviation. Almost all of you at this meeting from out of town flew here; the same is true of every business meeting in the United States. The great bulk of all technology for aircraft and aircraft engines has been generated by work aimed primarily at military aircraft and sponsored by the armed forces of various countries or by Government agencies such as NACA, one of the predecessor agencies of NASA.

Another obvious progeny of Government-sponsored technology is the commerical use of nuclear energy. In the past year, about 50% of all the electric powerplants ordered in the United States were nuclear plants. The civilian use of radioisotopes is small but significant. The bulk of the technology which permit these civilian developments was generated in the Government effort to produce nuclear weapons.

Let me tell you now about three technologies that originated or matured during the military efforts in World War II and that are among the most important dynamic areas of the civilian sector today. In 1943 Aberdeen Proving Ground was up to its ears trying to compute artillery tables. Over a hundred girls were performing calculations and the work was not being done fast enough. The 1st Lieutenent in charge of the girls, an assistant professor of mathematics in civilian life, remembered an informal report by a University of Pennsylvania professor on the possibilities of an electronic computer. In a meeting on April 9, 1943, it was decided to design and build the machine. The ENIAC, the first electronic computer, was completed in 1946. Since then the computer has been greatly improved. Much of this improvement has come from the computer industry itself, but a principal motivating factor was the computing needs of non-civilian technology which until recent years provided a large fraction of the market for the electronic computer and which to this day puts the greatest demands on its capabilities.

Automation or automatic control is not entirely a new field. Watt invented the flyball governor to control the speed of his steam engine in 1788. However, the first modern example of the automatic execution of more complex operations which we normally think about when we think of automation occurred in 1924 when Minorsky constructed a servo-device which was installed on the Battleship New Mexico to steer it automatically across the Gulf Stream. In the 1930's a number of theoretical papers basic to the theory of automatic control were written, but the field had not jelled. During World War II, the military were very interested in automatic fire control for such devices as radar controlled anti-aircraft guns. One result was the formation of the MIT Servomechanisms Laboratory where the work of the various contributors of the past was brought together and modern automatic control theory emerged.

The third technology connected with the World War II period arose from the needs of radar. Radar operates on short wavelengths (about 10 centimeters or less). Vacuum tubes were inefficient rectifiers of this high frequency. In the early days of radio, crystals such as Galena (lead sulphide) or silicon had been used for rectification but were soon replaced by vacuum tubes which were superior at the lower radio frequencies. It turned out that silicon rectifiers made very efficient rectifiers for radar frequencies and the first modern semi-conductor component was the result. Germanium diodes were also studied at this time and were found to be a satisfactory rectifier. One of the groups working on silicon and germanium rectifiers and on semi-conductor theory during this period was at Bell Labs. Shortly after World War II, members of this group, working now independent of the military need, but growing out of their work with semi-conductors during the war, invented the transistor. The potential utility of the device was immediately recognized and the Military Research and Development Board in 1951 instituted a crash program where facilities for the manufacture of semi-conductor devices were built concurrently with the design and development of equipment to use them. Today, Government-sponsored aerospace technology is still pushing the frontiers of semi-conducting devices.

This completes my three illustrations on spinoff from aerospace technology connected with World War II. Other illustrations from other time periods can be found. For example, food canning was developed to preserve food for the army of Napoleon. For another example, we are seeing today the birth of a new field of medicine sometimes called bioengineering which is the application of modern engineering technology to medicine. Much of this engineering technology is aerospace technology. Lasers are being used to repair retinas, cryogenics is being used in neurosurgery, cancer removal, prostatectomies, and other surgery. Hyperbaric oxygen chambers are being used in heart surgery, clean-room equipment is being used in hospitals, radioisotopes are used to find and treat cancer, instruments developed to monitor astronauts are monitoring intensive care patients, infrafred detectors are used to detect blood clots, accelerometers are used to detect muscle tremors, and so on.

In addition to these benefits of aerospace technology, I would like to point out another important civilian sector which benefits from aerospace technology. These are the technologies which underlie or support the more directly applied technologies. Take for example fabrication or metal working. It has been said that nearly every significant new advance in metal cutting and metal forming has been developed by groups not traditionally a part of that industry. A large fraction of these advances have come directly from aerospace technology or from commercial groups serving the aerospace market. The major fraction of the advances in metallurgy in the last decades have been supported by aerospace technology. High strength steels, high strength aluminum alloys, titanium, beryllium, zirconium, the high strength nickel and cobalt alloys, the refractory metals have all received major impetus from aerospace technology. Another field is the field of instrumentation. The instruments available today are greatly superior to the instrumentation available as little as three decades ago and much of this improvement stems from aerospace technology or from commerical firms selling to the aerospace market.

This completes my brief discussion of the second area of direct benefits from aerospace technology. When one considers the list: aviation and flight, nuclear energy, the high speed computer, automatic controls, semi-conductor electronics, canning, bioengineering, fabrication, metallurgy, instrumentation, I believe it is clear that great contributions have been made to the civilian sector.

The third area of direct benefit to the civilian sector from aerospace technology is that where substantial benefit arises from the accretion of many small improvements. There is sometimes a tendency to belittle the value of a high temperature paint or a high current switch or a weld seam tracker or the fact that PERT, a computerized schedule control system was used to manage Expo 67. However, to quote Jewkes, Somers, and Stillman in their book, The Sources of Invention, "There is no evidence which establishes definitely that technical or economic progress receives greater contributions from the few and rare large advances in knowledge than from the many and frequent smaller improvements." The many and frequent smaller improvements which aerospace technology in the large sense I am speaking of has contributed to the civilian sector are numberless. To give you some idea of the numbers we are dealing with, in one year at one NASA contractor 2538 innovations were reported. It is very difficult to talk about them in any way which gets across the main idea, that even though each individual one is of small significance the totality is of very great significance. What I decided to do was just list a tiny fraction of the tens of thousands of items which could be accumulated. Magnetic hammer, unique seismometer, new type of stretcher, foldable metal tube, automatic living cell analyzer, pattern extraction to improve pictures, miniaturized computer circuits, better bearing materials, air-brake dynamometer, pyrotechnic heaters, a method of ion plating, computer program to calculate combustion processes, ultra-sensitive pressure release valve, more ductile tungsten alloys, unique transducer for measuring temperature in inaccessible places, cold-cathode ionization gages, gas analyzer, laser balancing of gyros, vacuum chip collector, process to form organic polymers into shapes suitable for mechanical property tests, improved nickel-cadmium batteries, energy absorption device, high reliability components, new method of vacuum coating, very large hydrostatic bearing, advances in the hydrodynamics of slurries, improved nuclear magnetic resonance spectrometer, superconducting materials, lens design computer program, high temperature plastics, new composite materials, miniaturized memory device, peel tester for laminated materials, connector seal, torque filter, new solid lubricants, interference-filter wedges, heat flow detector, transparent gold coating, hail-resistant panels, self-propelled penetrometer, high grade adhesives, heat pipes, stick control system for independently powered wheels, coating with variable solar absorptivity, photosensitive field effect transistor, data compaction techniques, highly reliable telemetered communication, self-testing and repairing computer, maser refrigerant systems, Cassegrain antenna feeds, more stable sounding balloons, high temperature electrical materials, self-oscillating inverter, solid state ampere-hour integrator, cadmium-cadmium coulometer, variable field motor, thermal scale modeling, tire hydroplaning, aluminized plastic blanket, sight switch, pressure cuffs, back pressure regulator, parallel plate viscometer, micro lamp, laser tracking system, polysulfide printing rolls, printed cable, sintered oxide ceramics, soldering manual, refractory pressure sensitive tape, infrared micrometer, radioisotope thermoelectric generator, aluminum coating process, precision cable cutter and stripper, alkali silicate paint, textile loom monitors, refractory metal purification techniques. Had enough? I just listed about 80 small innovations. I could with some effort list 800 or 8000 more. No single one is of great importance, but the total is very important. Let me tell you of one more example in a lighter vein. A Northeast manufacturer made filament-wound rocket cases. His commercial applications of this technology were unusually wide range. He manufactures 8000-gallon tanks for railroad tank cars which weigh 5 tons less than steel tanks. He also produces filament-wound brassiere supports which out last other supports. Considering this last application, I guess you could say that space technology supports half the world.

I have spoken briefly on direct technical benefits which have already accrued from the aerospace technology of the last several decades including some from the space activity of the last nine years. Undoubtedly the full results from these activities are not felt or even predicted. As I noted in the introduction to this talk, the length of time required for the results of technological activity to make itself felt is often long. Also, our ability to predict the eventual worth of a particular piece of technology is poor.

Many examples exist, you have probably heard some. Let me give just one concerning Michael Faraday. Shortly after Faraday's death in 1867, a biographer, J. H. Gladstone, wrote a chapter on "The Value of His Works." He cited the following as Faraday's principal contributions: (1) a regenerative gas furnace to save coal in the melting of glass; (2) a method of ventilating light-house lamp burners; (3) by taking into account Faraday's concept of induction in dielectrics submarine cables could carry four signals instead of three; and (4) an electric arc was being considered as a light source for lighthouses. Forty years after Faraday's major discoveries, his biographer, looking for the "value of his discoveries", covered everything that causes us to honor Faraday at this symposium with a sentence "The good fruit borne by other researches may not be sufficiently mature but it doubtless contains the seeds of many useful inventions."

I do not know what great contributions aerospace technology is making today which will be clear to someone 40 years from now. I am probably no better a prognosticator than Faraday's biographer. Therefore, for the contributions of the future, let me propose some stand-ins. Let me show you three great spinoffs of the aerospace activity of the past, each of which was unexpected, unpredicted, and of considerable importance.

I particularly like the first example because it is clearly a spinoff of aerospace technology. I am going to tell you about an astronomer. We all remember the famous Caliph of Baghdad in the Arabian Nights, Harun-Al-Rashid. His son Al-Mamum ruled in Baghdad from 809-833 A.D. He added to the already intellectual atmosphere of the city by establishing an academy, an astronomical observatory, and a library. The astronomical observatory was established without any particular thought of spinoff to the civilian sector. One of the astronomers at the observatory in the early 800's was named Mohammed Ibn Musa Al-Khowarezmi, a free translation being Mohammed Son of Moses, the Khowarezmite. As an adjunct to his work in astronomy he was also active in mathematics. He constructed astronomical tables, wrote books on the astrolabe and on algebra, and translated Hindu works on astronomy and arithmetic. His arithmetic was widely used throughout the Arabic world. It was translated into Latin at about 1130 to 1140 A.D. by one or both of two Western Europeans, Adelard of Bath and Robert of Chester who studied under the Arab scholars in Spain. The title of the translated arithmetic was Algoritmi Di Numero Indorum. From this translation the Western World was introduced to Arabic numbers.

Galileo from time to time worked on military problems. He even wrote two books called Fortifications and Military Constructions. Sometime around 1600, he became interested in the path of an artillery projectile. He didn't publish the work until much later as part of his book Two New Sciences published in 1638. He said "I now propose to set forth those properties which belong to a body whose motion is compounded of two other motions...this is the kind of motion seen in a moving projectile." The flight of an artillery projectile was the aerospace technology of that time; the spinoff was the principal of superposition in problems of motion.

Early in 1798, war with France looked near. France announced that her captains would hang American seamen as pirates if found on British vessels. In March, President Adams informed Congress that the Pinckney mission to Paris had failed. Soon thereafter

Congress appropriated $800,000 for the procurement of muskets, but it was difficult to spend the money. Guns could not be purchased abroad because all nations who were normal sources were preparing for war. The only operating arsenal in the U.S., Springfield Arsenal, had just gotten into production and Harpers Ferry Arsenal was not yet in production. On May 1, 1798, Eli Whitney wrote the Government offering to manufacture muskets. On June 14, 1798 a contract was signed calling for the manufacture of 10,000 muskets of the design of the French-Charleville musket of 1763 for a price of $13.40 per musket. Whitney's approach was to manufacture the parts by machine and to have all parts interchangeable. The Government's purpose in this transaction was to buy muskets, the spinoff to the civilian sector was our modern system of mass production.

What has been the value to the world of interchangeable parts and mass production, or of the principle of superposition, or of the Arabic numbers? What values of comparable magnitude to the civilian sector are being generated in the aerospace programs of the past few and next few decades? I don't know, but I feel that they are in there.

Finally, I would like to discuss a benefit of the aerospace effort which is intangible, very difficult to evaluate and, in my judgment, pernaps more important than any or all of the preceding benefits. First we must make a digression and discuss the difference between innovating and non-innovating societies. By an innovating society I mean the society which makes changes, technological changes, social changes, political and economic changes which the non-innovating society does not. We are all familiar with examples of both kinds. Western Europe and the United States in the period from perhaps 1400 to the present time constitute an extremely innovative society. Greece from about 600 to 200 B.C. was a highly innovative society. China up to about 500 A.D. was an innovative society. China from about 500 to 1900 A.D. is a very good example of a non-innovative society. Nothing much changed except the ruling dynasty from time to time. These points can be made about innovating and non-innovating societies:

1. There have always been these differences back to remote antiquity.
2. Innovating societies have generally been the exception not the rule.
3. Innovating societies do not necessarily remain innovating societies.

Let us take these points up briefly.

There have always been innovating and non-innovating societies. We are familiar with examples of the last 2000 years. I have cited a few. Let us look to earlier times. Stuart Piggott in his book Ancient Europe discusses Europe in the period from

10,000 B.C. to perhaps a few hundred B.C. he observes:

> "What we can perceive, even in remote antiquity is a broad classification between innovating and conserving societies. In the one group, technological developments in the arts of peace and war must have been socially acceptable and therefore encouraged, in the other, once a satisfactory Modus Vivendi for the community within its natural surroundings had been achieved there seems to have been no urgent need felt to alter the situation."

D. D. Kosambi writing of ancient India discusses the Indus River Basin culture which existed in the period 3000 B.C. to 1750 B.C. and which was contemporary with and had a culture at one point rivaling that of Eygpt and Mesopotamia, great innovators of that day. He says:

> "What sets the Indus cities apart from developments in Egypt and Mesopotamia of the third millenium B.C.... (is the) lack of great changes...the pottery, the tool types remained the same,...the street plan remained fixed."

This is over a period of 1200 years. Even the house foundations were relatively unchanged through many rebuildings over hundreds of years.

Let us look at the second point. Innovative societies have been the exception not the rule. In the Far East during its great innovative period almost all innovation centered in a relatively small area of Northern China. The American continents before Columbus saw civilizations of some substance in Peru and Mexico but nowhere else.

The major innovative centers of the entire world from 3000 B.C. to a few hundred A.D. were concentrated in a circle perhaps 800 miles in radius covering Egypt, Asia Minor and Greece. The major innovative centers of the entire world from perhaps 1400 through 1800 were concentrated in an area only somewhat larger than the state of Alaska in England, France, Italy, Iberia, and Germany.

Let us look at the third point. Innovating societies don't stay innovating. They come and they go. Egypt and Mesopotamia, China, Greece, all great innovating societies in their time stopped innovating.

Summarizing, there have always been innovating societies; they have always been rare; they come and they go. The spark that, in 6000 years, has carried man from the primitive life of a stone-age hunter to the unbelievably complex world of today is a rare, transient spark and there is nothing we do more important than keeping this innovating spark alive.

What is it that causes a society to innovate? Your first thought might be that there would usually be clear causes of an economic, political or social nature. Over and over this turns out not to be the case. In 1295, Marco Polo returned from China and described a civilization which was a marvel compared to the Western Europe he knew. Yet Western Europe was on the verge of becoming the great innovating society of the next 600 years, while China remained unchanged. It is difficult to find any circumstances in 800 B.C. which favored Athens over say Argos, Thebes, Miletus, Sidon, Tyre, or any of a number of cities of the Near East. Turning to more ancient times, the origins of metallurgy lie in a restricted region of the Near East in spite of the fact that the principal centers of civilization lacked raw materials.

Quoting Piggott again:

> "Egypt...was always without resources of raw material... and Mesoptamia too had to import its ore. So far as ready supplies of raw material were concerned, our old world metallurgy could well have started in Ireland or Iberia, save for the fact that the stone-using peasantry of those parts lacked the precocity in technical innovation that characterized the otherwise comparable societies of Western Asia."

If political, social, or economic advantages are not sufficient to create an innovating society, what is? It is my belief that the greatest difference between innovating and non-innovating societies is in attitude or state of mind. That people in a society develop a belief in innovation, a faith that new ways should be pursued, that greater things can be done, and that this state of mind, this faith, grows and lives on successful example. People see new things being done and they know that more new things can be done. Let me tell you the story Representative John Davis of Georgia tells about the carpet industry in Georgia. I'll use his words.

> "About four decades ago a lady whose name was Mrs. White, who lived about six miles north of where I do in the Northwest part of Georgia, got out of a trunk a bedspread which had been in the trunk ever since the Civil War. She looked at it and found that it had been made from a piece of sheeting through which had been drawn pieces of yarn. These pieces of yarn had been cut off above and below the sheeting so it left a little tuft. That had resulted in a bedspread that had a design on it of flowers or something like that. At any rate, she decided to make another one, so she did. It sold quite readily. She engaged some other women to make more, and just as fast as they could make them they sold them, and it became a cottage industry in my area during the very depths of the depression in the early 1930's. But it flourished even in those days and it served to focus the attention of the people with their native-

born aptitude on the problem.

"Pretty soon somebody figured out a way to cut these tufts off by machine and sew them in by machine rather than having to do it with scissors. At that point it ceased to be a cottage industry and it began to be known as the tufting industry, which turned out bedspreads in greater quantity. Then along came a fellow who discovered that you could make a carpet the same way by pulling one fiber through a sheeting and cutting it off both above and below and then putting a glue baseon it. Then a man came along who discovered how to sew the yarn in without having to cut it off at all, just make a complete loop. That became the American Carpet Industry.

"In that little area which could be covered by a radius of 25 miles is now made 60 percent of the carpets consumed in the United States."

Representative Davis goes on to observe:

"I spent years thinking that what was holding our part of the country back was a lack of capital. I no longer think that. I think it is a frame of mind. The people in that area know this will work. They can make it work and it has worked."

This country is the innovative leader of the world today. Energy and treasure is poured into innovation and the totality of this innovation is changing the world. And we are doing it, not mainly because we are rich, but because,

"The people in (this) area know this will work.
They can make it work and it has worked."

This faith comes primarily from a few areas in which spectacular progress has been made in the last decade. Medicine and drugs, chemistry and the areas which have been fostered totally or in part by aerospace technology; the airplane, the electronics industry, the high speed computer, automation, space flight. Ask a child in the United States today for areas where man is doing great new things, which show that great new things can be done. Try and find one that doesn't mention space. Why as a nation today do we, without really much doubt that we can do it, talk about controlling the pollutant content of 3,000,000 square miles of atmosphere and billions of gallons per day of water flow? Why do we say that we will not accept the junky conglomeration that exists in the heart of our major cities, that the richest poor people in history should be better off, that the Negro does not have to live in rat-infested ghettos? I claim an important part of it all is seeing a man walk in space because we decided we wanted it. It's knowing that we can decide that man will land on the moon in a decade and know that it will be accomplished in about that time. And that if we can do this we can do almost anything else new that we really set our mind to.

I would like to conclude with a brief summary. Government-sponsored technology not specifically aimed at the civilian sector or aerospace technology in the large sense we have been using it here has been of enormous benefit to the civilian sector. It has produced current tangible results in satellite applications, has fostered a number of major innovations, and generated a host of smaller innovations. It is generating technology whose benefits will not be recognized for years, it is providing a part of the inspiration that keeps this country an innovating society. It, like other investments in new technology, is the best investment this country can make.